SPECIFICATION

TITLE OF THE INVENTION

APPARATUS AND METHOD FOR CONTROLLING CLUTCH OF MECHANICAL AUTOMATIC TRANSMISSION

Background of the Invention

1) Field of the Invention

The present invention relates particularly to an apparatus and method for controlling a clutch of a mechanical automatic transmission which is suitable for use in controlling a clutch at the time a vehicle starts to move (hereinafter may be called "at the time of start").

2) Description of the Related Art

A vehicle—which is equipped with a mechanical automatic transmission arranged to enable automatic transmission by providing a change gear mechanism and a clutch mechanism respectively with an actuator—performs clutch partial engagement control operation at the time of start (or when the vehicle moves slowly). As shown in, e.g., Fig. 8, the clutch partial engagement control is performed on the basis of a map of a clutch stroke speed with respect to a rate of change in an engine speed (i.e., a differential

value of the engine speed).

For instance, the rate of change in engine speed is C_1 ($C_1>0$), the clutch is controlled so as to move toward an engagement direction at a stroke speed V_1. When the rate of change in engine speed is C_2 ($C_2<0$), the clutch is controlled so as to move toward a disengagement direction at a stroke speed V_2. When the rate of change in engine speed is zero, the clutch is controlled so as to stay at the current position.

As a result, at the time of start of the vehicle, clutch partial engagement control operation is commenced at a point in time when a driver has stepped on an accelerator, and the clutch is gradually engaged, to thus accelerate the vehicle.

JP-A-6-117454 (hereinafter called "Patent Publication 1") describes a technique for computing a target engine speed at which a clutch is to be thrown in for smoothly driving a vehicle, from throttle opening achieved at the time of start, thereby increasing or decreasing an exciting current for an electromagnetic powder clutch such that an actual engine speed attains the target engine speed.

In a diesel engine, engine output torque corresponding to an accelerator position VA (%) set by the driver has a characteristic with respect to the engine speed such as that shown in Fig. 9.

As shown in Fig. 9, for example, when the

accelerator position is 0%, output torque assumes a value of 0 at an idle speed of 650 rpm. When the idle speed has increased to become higher than the engine speed, the engine output torque gradually decreases.

For instance, when the accelerator position is 10%, the higher the engine speed, the higher the engine output torque. However, the engine output torque has reached a peak (maximum torque) at a certain engine speed P_{10}, the engine output torque gradually decreases in subsequent operation. Similarly, even when the accelerator position is 20%, the higher the engine speed, the higher the engine output torque. However, the engine output torque reaches a peak at a certain engine speed P_{20}, and the engine output torque gradually decreases in a subsequent operation.

As mentioned above, the diesel engine has a parabolic characteristic, wherein, as the accelerator position increases, the peak of the engine speed shifts to a higher range, and the engine output torque gradually decreases after the engine speed has exceeded the peak.

Therefore, when the clutch partial engagement control operation is performed at the time of start of a vehicle without taking into consideration such an output torque characteristic, the clutch may be partially engaged while the engine speed remains below the engine speed achieved at the peak (the maximum

torque output) (i.e., a drop has arisen in engine speed) or higher than the engine speed achieved at the peak (i.e., a hike has arisen in engine speed).

In this case, even when clutch partial engagement operation has been performed, sufficient drive torque cannot be output, because the engine output torque is too low, thus posing difficulty in smooth start of the vehicle. Particularly, this problem becomes noticeable when the vehicle starts moving while on an uphill or when a vehicle with a heavy load starts moving.

In association with occurrence of such a problem, the time which lapses before the vehicle starts moving becomes longer; that is, the time during which the clutch is partially thrown in becomes longer, and hence the clutch may become abraded early, or noise due to an excessive hike in the engine speed may increase.

According to the previously-described technique of Patent Document 1, the engine speed at which maximum torque can be achieved is not set as a target rotational engine speed at all times. For this reason, when the vehicle is under heavy load, difficulty is encountered in smoothly starting the vehicle. Moreover, the clutch described in Patent Document 1 is of electromagnetic power type, wherein no attention is paid to abrasion developing in the clutch.

SUMMARY OF THE INVENTION

The present invention has been conceived in view of the foregoing drawback and aims at providing an apparatus and method for controlling a clutch of a mechanical automatic transmission enabling smooth start.

To this end, the present invention is characterized by a clutch controller of a mechanical automatic transmission which enables automatic transmission operation by means of providing a transmission gear mechanism with an actuator and a clutch mechanism with an actuator, the controller comprising: engine speed detection means for detecting an engine speed; accelerator position detection means for detecting the position of an accelerator; range setting means for setting an engine speed range in which engine output torque falls within a predetermined range including a maximum value at the position of the accelerator detected by the accelerator position detection means; and control means which effects direct engagement of a clutch when a vehicle is pulled away while controlling a connected state of the clutch such that the engine speed detected by the engine speed detection means falls within the engine speed range set by the range setting means.

According to this controller, output torque can be ensured at the start of a vehicle, thereby enabling

smooth start. Accordingly, when the vehicle starts to go while on an uphill or when the vehicle with a heavy load starts, stable start required by the driver becomes feasible.

Further, the partially-engaged clutch time can be diminished when compared with the case of a conventional clutch, and hence early abrasion of the clutch can be suppressed. Moreover, occurrence of an engine stall, which would otherwise be caused by an excessive drop in the engine speed in a low-rotational speed range, can be prevented, as can occurrence of an excessive hike in the engine speed within a high speed range, thereby preventing generation of noise.

The range setting means preferably sets a first threshold value at an engine speed lower than an engine speed at which the engine output torque becomes maximum at the position of the accelerator and sets a second threshold value at an engine speed higher than the engine speed, thereby setting the engine speed range.

The first threshold value and the second threshold value are preferably set in accordance with the position of the accelerator.

The control means preferably comprises a storage section for storing a map in which clutch stroke speeds corresponding to a rate of change in the engine speed are set with regard to three ranges; namely, a first

range which is lower in engine speed than the first threshold value, a second range falling between the first threshold value and the second threshold value, and a third range higher in engine speed than the second threshold value; a determination section for determining which one of the three ranges that the engine speed detected by the engine speed detection means falls within; and a clutch control section which selects from the map a clutch stroke speed corresponding to the range determined by the determination section and controls the clutch stroke speed of the clutch.

The storage section preferably stores, as the map, control lines corresponding to the three ranges on coordinates formed from the rate of change in the engine speed and the clutch stroke speed; the control line of the second range is set so as to increase the clutch stroke speed in a clutch engagement direction when the rate of change in the engine speed has increased and to increase the clutch stroke speed in a clutch disengagement direction when the rate of the engine speed has decreased; and the control line of the first range is preferably a line obtained as a result of the control line in the second range having been shifted toward an increase in the rate of change in the engine speed, and the control line of the third range is a line obtained as a result of the control

line of the second range having been shifted toward a decrease in the rate of change in the engine speed.

The storage section preferably stores a map in which are set clutch stroke speeds corresponding to the rate of change in the engine speed in connection with a plurality of ranges into which the first range has been divided; the determination section determines which one of the plurality of ranges within the first range includes the engine speed detected by the engine speed detection means when the detected engine speed falls within the first range; and the clutch control section preferably controls the clutch stroke speed of the clutch by means of selecting, from the map, a clutch stroke speed corresponding to the range determined by the determination section.

The storage section preferably stores, as the map, sub-control lines corresponding to the plurality of ranges within the first range on coordinates formed from the rate of change in engine speed and the clutch stroke speed; and the sub-control lines assigned to the plurality of ranges within the first range are preferably formed by shifting at intervals the control line of the second range toward an increase in the rate of the engine speed.

The storage section preferably stores a map in which are set clutch stroke speeds corresponding to the rate of change in the engine speed in connection

with a plurality of ranges into which the third range has been divided; the determination section preferably determines which one of the plurality of ranges within the third range includes the engine speed detected by the engine speed detection means when the detected engine speed falls within the third range; and the clutch control section preferably controls the clutch stroke speed of the clutch by means of selecting, from the map, a clutch stroke speed corresponding to the range determined by the determination section.

The storage section preferably stores, as the map, sub-control lines corresponding to the plurality of ranges within the third range on coordinates formed from the rate of change in engine speed and the clutch stroke speed; and the sub-control lines assigned to the plurality of ranges within the third range are preferably formed by shifting at intervals the control line of the second range toward a decrease in the rate of the engine speed.

A method for controlling a clutch of a mechanical automatic transmission which enables automatic transmission operation by means of providing a transmission gear mechanism with an actuator and a clutch mechanism with an actuator, the method comprising the steps of: detecting an engine speed and the position of an accelerator; setting a first

threshold value at an engine speed lower than an engine speed at which the engine output torque becomes maximum at the detected position of the accelerator and setting a second threshold value at an engine speed higher than the engine speed; and effecting direct engagement of the clutch while controlling a connected state of the clutch such that the detected engine speed falls between the set first threshold value and the second threshold value.

According to this method, output torque can be ensured at the start of a vehicle, thereby enabling smooth starting. Accordingly, when the vehicle starts while on an uphill or when the vehicle with a heavy load starts, stable start required by the driver becomes feasible.

Preferably, when the detected engine speed is lower than the first threshold value, the clutch is controlled so as to be disengaged; and, when the detected engine speed is higher than the second threshold value, the clutch is controlled so as to be engaged.

A low engine speed sub-threshold value is preferably set at an engine speed which is lower than the first threshold value; and, when the detected engine speed is lower than the engine speed sub-threshold value, a clutch stroke speed is preferably increased toward the clutch disengagement

direction as compared with a case where the detected engine speed falls between the first threshold value and the low engine speed sub-threshold value.

A plurality of the low engine speed sub-threshold values are preferably set at engine speeds lower than the first threshold value; and, when the detected engine speed falls between an $(n+1)^{th}$ (n: natural number) low engine speed sub-threshold value and an $(n+2)^{th}$ low engine speed sub-threshold value toward a lower engine speed from the first threshold value, the clutch stroke speed is preferably increased toward the clutch disengagement direction as compared with a case where the detected engine speed falls between an n^{th} low engine speed sub-threshold value and the $(n+1)^{th}$ low engine speed sub-threshold value.

A high engine speed sub-threshold value is preferably set at an engine speed higher than the second threshold value; and, when the detected engine speed is higher than the high engine speed sub-threshold value, the clutch stroke speed is increased toward the clutch engagement direction as compared with a case where the detected engine speed falls between the first threshold value and the high engine speed sub-threshold value.

A plurality of the high engine speed sub-threshold values are set at engine speeds higher than the first threshold value; and, when the detected

engine speed falls between an $(n+1)^{th}$ (n: natural number) high engine speed sub-threshold value and an $(n+2)^{th}$ high engine speed sub-threshold value toward a higher engine speed from the first threshold value, the clutch stroke speed is increased toward the clutch engagement direction as compared with a case where the detected engine speed falls between an n^{th} high engine speed sub-threshold value and the $(n+1)^{th}$ high engine speed sub-threshold value.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram schematically showing a vehicle equipped with an apparatus for controlling a mechanical automatic transmission according to an embodiment of the present invention;

Fig. 2 is a block diagram schematically showing a vehicle according to the embodiment of the present invention;

Fig. 3 is a diagram showing an engine output characteristic for describing range setting means according to the embodiment of the present invention;

Fig. 4 is a map for setting a threshold value of an accelerator position according to the embodiment of the present invention;

Fig. 5 is a map for setting a clutch stroke speed with respect to a rate of change in engine speed according to the present embodiment of the invention;

Fig. 6 is a graph showing a change in engine speed achieved at the start of the vehicle according to the embodiment of the present invention;

Fig. 7 is a map for a modification of the present invention;

Fig. 8 is a map for setting a clutch stroke speed with respect to a rate of change in a conventional engine; and

Fig. 9 is a diagram showing an engine output characteristic of a common engine.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

An embodiment of the present invention will be described hereinbelow by reference to the drawings.

Figs. 1 through 6 are for describing an apparatus and method for controlling the clutch of a mechanical automatic transmission according to an embodiment of the invention. As shown in Fig. 1, the mechanical automatic transmission is arranged so as to enable automatic transmission by means of providing a gearbox (a speed-change gear mechanism) 8 and a clutch (a clutch mechanism) 9, which are analogous to those of a manual transmission vehicle, with actuators 81 and 91, respectively.

As shown in Fig. 2, the vehicle of the present embodiment is provided with an engine 7, the gearbox 8, and the clutch 9, and an output shaft 7a of the

engine 7 and an input shaft 8a of the gearbox 8 are connected together by way of the clutch 9.

When the clutch 9 is thrown in, the engine torque output from the engine 7 is transmitted to a drive wheel (not shown) by way of the gearbox 8, thereby driving the vehicle. In Fig. 2, the arrow designates the direction in which a clutch plate is to be actuated.

As shown in Fig. 1, the clutch 9 is controlled by an ECU 1, as are the engine 7 and the gearbox 8. In detail, the clutch 9 is controlled by means of driving the actuator 91.

Accordingly, the ECU 1 is supplied with a signal output from a vehicle speed sensor 2 for detecting the speed of the vehicle, a signal output from an engine speed sensor (i.e., engine speed detection means) 5 which detects or computes the number of rotations of the engine output shaft 7a, and a signal output from an accelerator position sensor (APS; accelerator position detection means) 6 for detecting the extent to which an accelerator pedal (not shown) is depressed.

As mentioned previously, the engine output torque with respect to the driver's accelerator position VA(%) essentially has a characteristic with respect to the engine speed such as that shown in Fig. 3. Fig. 3 shows an engine output characteristic of a diesel engine; that is, output torque characteristics achieved when the accelerator

position is 0%, 30%, and 100%.

The controller makes up for a deficiency in torque, which arises at start (or during slow motion) of the vehicle equipped with the mechanical automatic transmission, thereby performing optimum clutch partial engagement control which enables more smooth start of the vehicle. By way of an example, clutch partial engagement control to be performed at an accelerator position of 30% will now be described.

As shown in Fig. 1, the controller has functions corresponding to a range setting section (range setting means) 10, a determination section 11, a storage section 12, and a clutch control section 13. Here, control means is constituted of the determination section 11, the storage section 12, and the clutch control section 13.

The range setting section 10 is arranged to set an engine speed range in which the engine output torque assumes a predetermined range including a maximum value at the accelerator position detected by the accelerator position sensor 6.

Specifically, as shown in Fig. 3, a threshold value (i.e., a first threshold value) N_A is set to an engine speed lower than the engine speed N_P at which output torque assumes a peak (i.e., maximum output torque) P_{30}, and another threshold value (i.e., a second threshold value) N_B is set to an engine speed higher

than the engine speed N_P. Thereby, the engine speed is divided into three ranges; that is, a range R_1 which is lower in engine speed than the threshold value N_A; a range R_2 which is located between the threshold values N_A and N_B; and a range R_3 which is higher in engine speed than the threshold value N_B.

In the embodiment, the threshold values N_A and N_B are set so as to be substantially equidistant from the engine speed N_P, and the range of engine speed between the threshold values N_A and N_B is set to, e.g., 300 to 400 rpm.

Since the engine output torque characteristic shown in Fig. 3 is a schematic view, the peak P_{30} is shown to be pointed. However, if the vertex of the peak P_{30} assumes the shape of a gentle-sloping curve, the range of rotational speed is preferably set wider.

As a matter of course, the maximum output torque (peak) changes according to the accelerator position, and hence the threshold values N_A and N_B are set according to the accelerator position so that engine output torque corresponding to the accelerator position can be obtained. For example, the threshold values N_A, N_B are preferably set on the basis of the map shown in Fig. 4.

The determination section 11 determines which one of the ranges R_1, R_2, and R_3 includes the engine speed detected by the engine speed sensor 5.

As shown in Fig. 5, the storage section 12 stores a map of a clutch stroke speed with respect to the rate of a change in engine speed (i.e., a differential value of the engine speed).

The map includes three control lines L_1, L_2, and L_3. On the basis of a result of determination made by the determination section 11, the clutch control section 13 selects any one from the three control lines, as required, and the thus-selected line is used for controlling the clutch at start of the vehicle.

Here, the respective control lines are described. First, the line L_2 is a control line used for controlling the conventional clutch, as well. The line L_2 shows that the clutch stroke is retained at the current position when the rate of change in engine speed is 0 (neither increases nor decreases). Further, the line L_2 also shows that, when the rate of change in engine speed is increasing, the clutch stroke speed toward the direction of clutch engagement (i.e., an engagement direction) is increased and that, when the engine speed is decreasing, the clutch stroke speed toward the direction of disengagement of the clutch (a disengagement direction) is increased.

The line L_1 is a control line obtained by means of shifting the line L_2 toward a direction in which the rate of change in engine speed ascends (i.e., a rightward direction in Fig. 5), by a predetermined

rate of change S_1. Specifically, the line L_1 shows that the clutch stroke is retained at the current position when the rate of change in engine speed is S_1 ($S_1>0$). When the rate of change in engine speed is greater than S_1, the clutch stroke speed toward the direction of clutch engagement (i.e., the engagement direction) is increased. When the rate of change in engine speed is lower than S_1, the clutch stroke speed toward the direction of clutch disengagement (i.e., the disengagement direction) is increased.

When attention is paid to, e.g., a case where the rate of change in engine speed is 0, the line L_1 shows an increase in the clutch stroke speed toward the clutch disengagement direction.

Therefore, when the clutch is controlled in accordance with the line L_1, the rate of change in engine speed gradually converges to S_1, and the clutch stroke is retained in the state of S_1 (i.e., the clutch is engaged such that the engine speed increases), and hence the engine can be retained at a high rotational speed. As a result, engine speed in the range R_1 can be increased to the range R_2, and the torque achieved in the range R_2; that is, torque close the maximum torque, can be output.

The line L_3 is a control line formed by means of shifting the line L_2 toward the direction in which

the rate of change in engine speed descends (i.e., a leftward direction in Fig. 5) by a predetermined rate of change S_2. The line L_3 shows that the clutch stroke is retained at the current position when the rate of change in engine speed S_2 ($S_2>0$) is achieved. When the rate of change in engine speed is greater than S_2, the clutch stroke is increased toward clutch engagement (i.e., the engagement direction). When the rate of change in engine speed is lower than S_2, the clutch stroke is increased toward clutch disengagement (i.e., the disengagement direction).

When attention is paid to, e.g., a case where the rate of change in engine speed is 0, the line L_3 shows an increase in the clutch stroke speed toward the clutch engagement direction.

Therefore, when the clutch is controlled in accordance with the line L_3, the rate of change in engine speed gradually converges to S_2, and the clutch stroke is retained in the state of S_2 (i.e., the clutch is engaged such that the engine speed decreases), and hence the engine can be retained at a low rotational speed. As a result, engine speed in the range R_3 can be decreased to the range R_2, and the torque achieved in the range R_2; that is, torque close the maximum torque, can be output.

When a change has arisen in the accelerator position output from the accelerator position sensor

6 at the start of the vehicle; that is, when the vehicle speed detected by the vehicle speed sensor 2 is at a predetermined speed or less, any one of the lines L_1, L_2, and L_3 is selected from the map stored in the storage section 12 on the basis of the result of determination made by the determination section 11, to thus control the clutch 9.

Specifically, when the determination section 11 has determined that the engine speed falls within the range R_1, the clutch control section 13 selects the line L_1 from the map, to thus perform clutch partial engagement operation while controlling the clutch stroke in accordance with the line L_1.

When the determination section 11 has determined that the engine speed falls within the range R_2, the clutch control section 13 selects the line L_2 from the map and performs clutch partial engagement while controlling the clutch stroke in accordance with the line L_2.

Further, when the determination section 11 has determined that the engine speed falls within the range R_3, the clutch control section 13 selects the line L_3 from the map and performs clutch partial engagement while controlling the clutch stroke in accordance with the line L_3.

Specifically, when the engine speed falls within the range R_1, the clutch control section 13 performs

clutch partial engagement control so as to increase the engine speed (i.e., the engine speed is on the high side). When the engine speed falls within the range R_2, the clutch control section 13 performs clutch partial engagement control so as to maintain the engine speed. When the engine speed falls within the range R_3, the clutch control section 13 performs clutch partial engagement control so as to decrease the engine speed (i.e., the engine speed is on the down side).

The clutch controller of the mechanical automatic transmission according to the embodiment of the invention is configured as mentioned previously. As shown in, e.g., Fig. 6, when the driver has pressed down on the accelerator to start the vehicle (i.e., a point in time t_1 shown in Fig. 6), the engine speed increases. However, clutch partial engagement control is performed such that the engine sped falls between the threshold values N_A and N_B, and the clutch is completely engaged when the engine speed has become synchronized with the clutch speed (i.e., a point in time t_2 shown in Fig. 6), whereupon the clutch partial engagement control is terminated.

As mentioned previously, according to the controller and controlling method of the invention, the drive torque can be ensured without fail even at the time of start of the vehicle, and hence a deficiency in torque, which arises at the start of the vehicle

in the related art, can be made up for, thereby enabling a smoother start. Consequently, for example, when a vehicle starts while on an uphill or a vehicle with heavy load starts, stable start required by the driver becomes feasible.

The vehicle has hitherto failed to start smoothly because of a deficiency in torque, and hence the time required to perform clutch partial engagement becomes excessive. However, according to the controller and controlling method of the invention, the smooth start required by the driver is feasible, and hence the time required to perform clutch partial engagement can be reduced as compared with the case of the conventional clutch, and hence early abrasion of the clutch can be suppressed.

Further, there can be prevented occurrence of engine stall, which would otherwise be caused by an excessive decrease in the engine speed in the low speed range (i.e., the engine stalls as a result of the engine output torque having failed to overcome the load of the engine). Further, an excessive hike in the engine speed in the high speed range can be prevented, which in turns prevents issuance of noise.

Although the embodiment of the invention has been described thus far, the present invention is not limited to the embodiment and can be carried out while being modified variously without departing from the

gist of the present invention.

For instance, the embodiment is configured such that, when the engine speed is lower than the threshold value N_A (i.e., in the range R_1), clutch control is performed in accordance with the line L_1. However, in addition to the line L_1, a plurality of additional control lines may be provided rightward with reference to the line L_1, thereby performing clutch control operation more elaborately in accordance with the magnitude of the engine speed. Similarly, when the engine speed is higher than the threshold value N_B (i.e., in the range R_3), a plurality of additional control lines may be provided leftward with reference to the line L_3 in addition to the line L_3, whereby clutch control may be performed more elaborately in accordance with the magnitude of the engine speed.

More specifically, a plurality of (e.g., "n") sub-threshold values are set at an engine speed lower than the threshold value N_A (i.e., low engine speed sub-threshold values). As shown in Fig. 7, sub-control lines a_0, a_1, … a_{k-1}, a_k corresponding to the ranges partitioned by the plurality of the sub-threshold values are added to the map. For example, the sub-control line a_0 shown in Fig. 7 is a line corresponding to a range between the threshold value N_A and a sub-threshold value first appearing in the direction from the threshold value N_A to the

lower engine speed. The sub-control line a_1 is a line corresponding to a range between the fist sub-threshold value and a second sub-threshold value. The sub-control line a_{k-1} is a line corresponding to a range between the $(n-1)^{th}$ sub-threshold value and the n^{th} sub-threshold value. The sub-control line a_k is a line corresponding to a range which is lower in engine speed than the n^{th} sub-threshold value. Therefore, for example, the engine speed detected by the engine speed sensor 5 falls within the range between the first sub-threshold value and the second sub-threshold value with reference to the direction from the threshold value N_A to the lower engine speed (i.e., the sub-control line a_1), the clutch stroke speed is increased toward the clutch disengagement direction to a greater extent than when the engine speed falls within the range between the threshold value N_A and the first sub-threshold value (i.e., the sub-control line a_0).

In other words, a plurality of sub-threshold values are set at an engine speed which is lower than the threshold value N_A. When the engine speed detected by the engine speed sensor 5 falls within the range between the $(n+1)^{th}$ ("n" is a natural number) sub-threshold value and the $(n+2)^{th}$ sub-threshold value with reference to the direction from the threshold value N_A to the low engine speed, the clutch

stroke speed toward the clutch disengagement direction is increased as compared with the case where the engine speed falls within the range between the n^{th} sub-threshold value and the $(n+1)^{th}$ sub-threshold value.

By means of such a configuration, when the engine speed detected by the engine speed sensor 5 is at a level which is lower in engine speed than the threshold value N_A, the clutch stroke speed toward the clutch disengagement direction can be increased stepwise as the engine speed falls to the lower engine speed, and hence a hike in the speed of the engine in the range R_1 can be controlled with high accuracy.

More specifically, a plurality of (e.g., "n") sub-threshold values are set at an engine speed higher than the threshold value N_B (i.e., high engine speed sub-threshold values). As shown in Fig. 7, sub-control lines b_0, b_1, … b_{k-1}, b_k corresponding to the ranges partitioned by the plurality of the sub-threshold values are added to the map. For example, the sub-control line b_0 shown in Fig. 7 is a line corresponding to a range between the threshold value N_B and a sub-threshold value first appearing in the direction from the threshold value N_B to the higher engine speed. The sub-control line b_1 is a line corresponding to a range between the fist sub-threshold value and a second sub-threshold value.

The sub-control line b_{k-1} is a line corresponding to a range between the $(n-1)^{th}$ sub-threshold value and the n^{th} sub-threshold value. The sub-control line b_k is a line corresponding to a range which is higher in engine speed than the n^{th} sub-threshold value. Therefore, for example, the engine speed detected by the engine speed sensor 5 falls within the range between the first sub-threshold value and the second sub-threshold value with reference to the direction from the threshold value N_B to the higher engine speed (i.e., the sub-control line b_1), the clutch stroke speed is increased toward the clutch engagement direction as compared with the case where the engine speed falls within the range between the threshold value N_B and the first sub-threshold value (i.e., the sub-control line b_0).

In other words, a plurality of sub-threshold values are set at an engine speed which is higher than the threshold value N_B. When the engine speed detected by the engine speed sensor 5 falls within the range between the $(n+1)^{th}$ ("n" is a natural number) sub-threshold value and the $(n+2)^{th}$ sub-threshold value with reference to the direction from the threshold value N_B to the high engine speed, the clutch stroke speed toward the clutch engagement direction is increased as compared with the case where the engine speed falls within the range between the n^{th}

sub-threshold value and the $(n+1)^{th}$ sub-threshold value.

By means of such a configuration, when the engine speed detected by the engine speed sensor 5 is at a level which is higher in engine speed than the threshold value N_B, the clutch stroke speed toward the clutch engagement direction can be increased stepwise as the engine speed falls to the lower engine speed, and hence a drop in the speed of the engine in the range R_3 can be controlled with high accuracy.

Although in the foregoing descriptions a plurality of sub-threshold values are set at a level which is lower in engine speed than the threshold value N_A, as a matter of course, it may be the case that only one sub-threshold value is set. Similarly, although in the foregoing descriptions a plurality of sub-threshold values are set at a level which is higher in engine speed than the threshold value N_B, as a matter of course, it may be the case that only one sub-threshold value is set.

Although the sub-threshold values are set in both the ranges R_1 and R_3, it may be the case that the sub-threshold values is set in only one of the ranges R_1 and R_3.

In the embodiment, one line is selected from the map stored in the storage section 12. However, maps for the lines L_1, L_2, and L_3 (i.e., three maps) may

be stored in the storage section 12, and any one may be selected from the three maps, to thereby control the clutch.